International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering (IJAREEIE)

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 7.122|

||Volume 9, Issue 6, June 2020||

Review on All Basic Scale Technologies

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ABSTRACT: This paper presents the different types of the Chip Integration technologies (mostly). As, we all know that the whole Electronics Industry depends totally on the Silicon based Chips, which are embedded by the different types of the components like transistors (Silicon based), etc. These all are silicon based, as silicon is widely used material in Chip manufacturing process because, it's available abundantly in nature and most importantly it's cheap as compared to other conductive (electric property) materials. This Chip Integration Technology started with SSI Technology and came up with some popular technologies like, LSI & VLSI.

KEYWORDS: Transistors, Silicon, Scale Integration, Chips, Moore Law, VLSI, Integrated Circuits (IC's)

I. INTRODUCTION

In today's era, the Electronics emerges as a boom to the mankind as it is being applicable in every sector(s). Like robotic arms, lasers (optics), etc are few of the many devices or the technologies which depends only on the single chip i.e., Silicon chip(s). These silicon chips are the thin (in mm or nm or even less) sheets of the pure silicon (processed) embedded with the components working as an embedded system. These silicon chips can be used in the USB, clock, printer, etc. The 1st chip was designed by "Jack Kilby" said to be "Father of IC's". He used a chip (or, substrate) of germanium in his 1st chip presented on 12th September, 1958 at Texas Instruments. Though, the 1st IC's were based on the SSI. The term "Large Scale Integration" (LSI) was coined by "Rolf Laudauer" scientist at IBM. On the basis of this SSI, MSI, VLSI, ULSI were also given.

II. SSI (SMALL SCALE INTEGRATION)

This Transistor Technology is the 1st one to come into show, and the circuits used in this particular one contains a few numbers of Transistors embedded on it. The Number of Transistors could range in say few Tens (10^1). These were used in main projects back in the history when enhancement and development of the computer and technology were on the merge of peak. Like computers used during the America's Apollo Mission are based on this SSI technology. And they were also used once in the Sound Processor of the T.V. Receivers. Ex =SL201 (Plessey), etc. Also, the 1st MOS Chips were SSI based only, which may consist of the 12 to 16 transistors on chips.

III. MSI (MEDIUM SCALE INTEGRATION)

This Transistor Technology is the next in the series after SSI circuits. Here, as the name suggest the circuits contains more than the previously said transistors say, about Hundreds (10^2) in Numbers on a single chip.

Now these chips provide the more scope than SSI because, these allow more components to be embedded in that small area only. And this all get possible by the MOSFET scaling, which allows the more transistors to be placed on the chips. Ex = 16bit shift register by Frank Wan lass, having 120 transistors embedded on a single chip.

IV. LSI (LARGE SCALE INTEGRATION)

This Transistor Technology, now deals with the embedding of the components on the chip not in tens or hundreds but in this it's going up to Ten Thousand (10^4) on a single chip. That's why it is used in more. Now by again by the MOSFET scaling the chips are uses to place more transistors leading to the MOS LSI chips. And this made possible a CPU to be implemented using a number of the transistors on a single chip. Ex = 1K calculators, or 4K microprocessors or 10K microprocessors chips (2nd Gen). Most famous of them were the Intel's 1103 DRAM, which was LSI based DRAM chip having about 1K transistors embedded on single chip.

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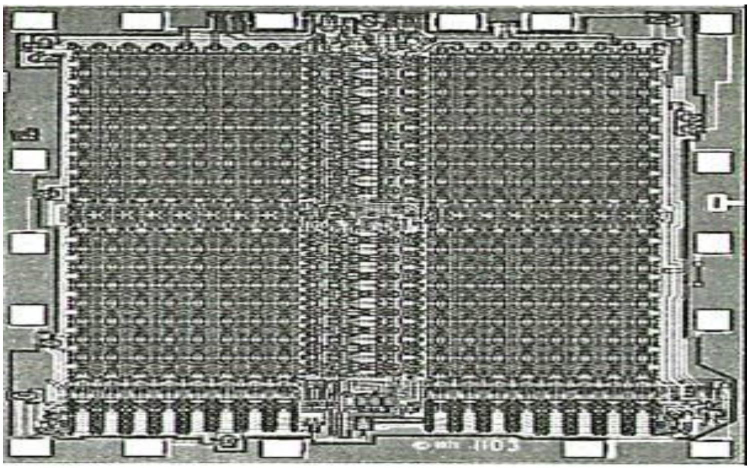

Fig.1 INTEL 1103 Dram

V. VLSI (VERY LARGE SCALE INTEGRATION)

This Technology comes into picture after the SSI & LSI. And thus, by this the circuit may carry up to 10 numbers of Transistors on the single chip. In 1970, during the early 1970s, MOS integrated circuit technology enabled the very large-scale integration (VLSI) of more than 10,000 transistors on a single chip. And because of large number of the transistors, the heat dissipation is less in this. But on other hand it is more durable and efficient than SSI & LSI.

Fig. 2 VLSI Chip

VI. ULSI (Ultra Large Scale Integration)

This technology comes into picture when the greater numbers of transistors have to be embedded on a single silicon chip. Here, the number of transistors can be embedded up to a level of 10(i.e., 1 million or even more)
Depending upon this Technology, the current trends i.e., Artificial Intelligence Machine learning, Cloud computing are totally based and ULSI is said to be their heart. Because, these all requires the smart chips which can work along with the number of the smart other chip modules (embedded systems). For this requires a million or more components to be embedded on single chip. Thus, ULSI is powering fifth generation computers and its related applications like Robotics, Neural networks, Expert systems, Game playing and Natural languages, etc. This shows that, the devices based on the ULSI are smart, compact; consume less power, thus more efficient than before.

VII. WSI (WAFER SCALE INTEGRATION)

So, with the ULSI, the AI gained a boom, but with the more advancement in the technology the ULSI seemed to failed, because the Moore laws upon which the numbers of previous Integration technologies are based have become a thing

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of past because the chips can't be now embedded more based on their formula. So, to conquer this problem the scientist and engineers came up with a new technology which is primarily based upon the previous one, but is totally new thing. This new technology is called "Wafer Scale Integration" i.e., WSI. Thus, this Technology was developed subsequent to the ULSI. Though, it's similar to the previous Integrating Techniques but, here instead of making the small chip integration (or, embedding on a single small chip), the designer or the scientist prefers the whole single silicon wafer(s). That's how a large amount of area can be obtained by sacrificing the quality of the wafer (which may have some defects in certain area). And that's how without cutting a single chip we are getting the IC's. And because of this big flaw in this technique which can certainly leads to the partial or complete failure of the chip and that's why it doesn't remain in the trend. And have much less priority than the others who are even prior to it.

VIII. IC (Integrated Chip Technology)

A circuit in which all or some of the circuit elements are inseparably associated and electrically interconnected so, that it is considered to be indivisible for the purposes of construction and commerce. As All Arrays of components, microscopic circuits and semiconductor wafer material base are integrated together to form a single chip, hence, it is called as integrated circuit or integrated chip or microchip. The 1st Integrated Chip was made by Jack Kilby. IC's Applications are in the field of consumer applications, defense, space, Automotive, etc.

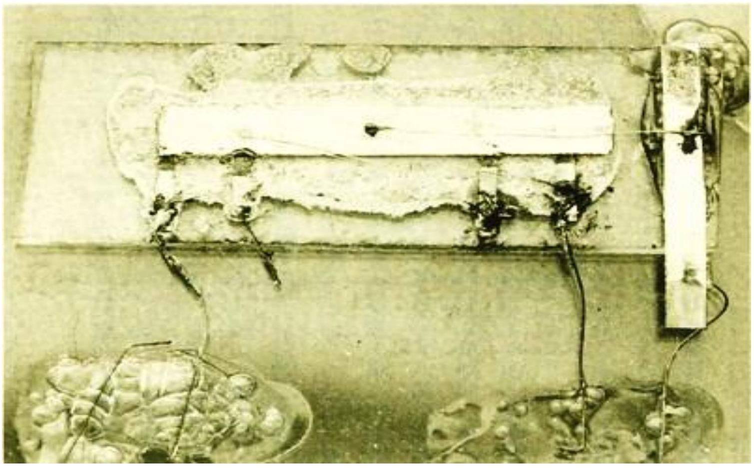

Fig. 3 1958: 1st Integrated Circuit

IX. MOORE's LAW

Scientist & Intel's Founder "Gordon Moore" stated in his one of the earliest theories that the number of transistors or the components should be doubled every single year. But, with further research and observation he later modified his own law and again gave it with some modification. Now this time he stated that the number of transistors or the components should be made double on the single chip almost after 2 years but not in single year (as stated before).

It results in following aspects (which become true)

1. Increasing Functionality
2. Increasing Operation
3. Decreasing Cost of Circuit & Components
4. Decrease in Power Consumption (Circuit)
5. Increase in Memory Capacity & Speed

And because of this law only, the chips are being developed efficiently with not only with hundreds or thousands but with a million or billions or even with lots of more transistors in today's time. And this even depends now on the user's requirement also.

Even with this much importance and requirement of this law, it have some limitations like,

i) As it states the number of transistors (components) will increase on chip every 18 or 24 months, but after some time it will become baseless and cross its limits.

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ii) In today's time, his theory of doubling the transistors every 18th month seems to be getting declined as the number of transistors in a particular area are getting larger in amount, space getting less according to them.

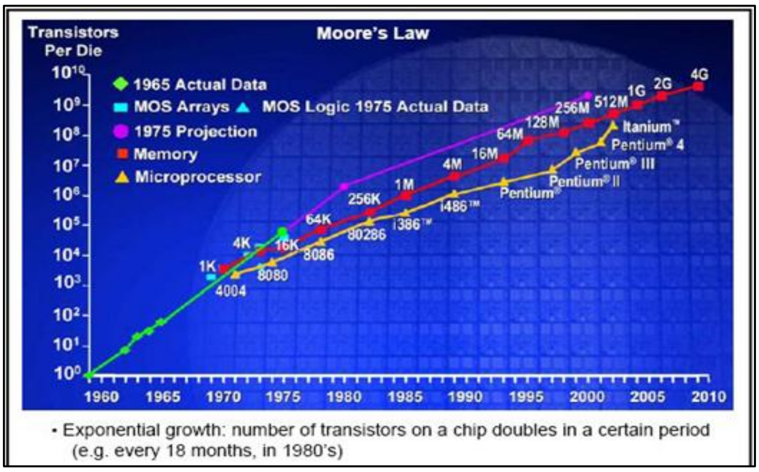

Fig. 4 Moore's Law

X. IC's Generation Summary

Serial Numbers	IC Generations	Invention Year	Transistors Numbers
I.	SSI	1964	10^1
II.	MSI	1968	10^2
III.	LSI	1971	10^3
IV.	VLSI	1980	10^4
V.	ULSI	1984	10^5
VI.	WSI	1990	10^6
VII.	3D-IC	1964-1969	10^7

XI. CONCLUSION

A number of different chip integration technologies from SSI to VLSI & to ULSI to WSI all are discussed in this paper above. From this work we can conclude that, how are the electronic chips that is said to be heart of any electronic devices or machinery that can be manufactured by using these different technologies efficiently, as per needs, as per cost, etc. Thus this shows a great significance of chip integration in the field of electronics.

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